THE ECONOMIC VALUE OF A GEOLOGICAL SURVEY,

BEING

A POPULAR LECTURE

BEFORE THE

ATHENÆUM OF ST. JOHNS, NEWFOUNDLAND,

DELIVERED

THE 15TH FEBRUARY, 1869,

BY

ALEX. MURRAY ESQ.

OF THE GEOLOGICAL SURVEY OF CANADA.

Montreal:
PRINTED BY JOHN LOVELL, ST. NICHOLAS STREET.
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CANADA

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THE last time I had the honor of addressing you in this same place, I did so with much diffidence, seeing that in taking such a matter as a lecture in hand, I was assuming a position so new, and out of my usual line, that I feared I might fail in making my subject either interesting or even intelligible to my audience, or rather I might simply say at once, that I should break down.

The kind and flattering manner however with which you were pleased to receive me on that occasion, has encouraged me to present myself once more, in hopes that the same subject, somewhat extended, may prove, not only of a little temporary interest, but may lead, on the part of some of my hearers, to further inquiry regarding matters bearing upon natural science.

When I last addressed you, I purposely abstained from entering too deeply into all the complications of geological detail, and satisfied myself with shewing a sort of general synopsis of the sequence of geological formations, and their several mineral peculiarities, especially as regarded their fossil contents. I did so as well as I could in the most familiar language, and fearing lest the subject might not be of a very attractive nature, I limited myself to the shortest time in which it was possible to say anything at all. I was glad, however, indeed to find subsequently that there were many among my audience who expressed regret that I had not been more diffuse, and who were pleased to say they could have listened with attention to much more than I delivered on a subject so replete with interest and instruction. Such sentiments then on your part being taken for granted, I shall at once proceed to show in the best manner I am capable of,

1.—*The great interest and advantage to be derived from studies connected with natural science generally.*

2.—*The general nature of Geological Structure, and the inestimable value of fossil remains, requisite knowledge of which is directly connected with the study of modern natural history in all its branches.*

3.—*The Geological Structure of Newfoundland, and the bearing which a knowledge of that structure has upon the development of all its natural resources.*

It is a very old saw, and a very true one, that "it takes a wise man to know himself," and it takes additional wisdom after that knowledge is acquired, to perceive the fact that the most learned amongst us, with all his learning, may still be said to remain in the profoundest ignorance. Indeed it may well be said that a man only begins to be getting wise when he discovers his insignificance. But notwithstanding these facts, there are many, even among educated men, who affect to sneer at inquiries touching upon natural science, although the fact cannot be disputed that upon it, in one or other of its innumerable branches, the whole fabric of civilization and modern invention is founded. How frequently do we hear a jeer or a joke passed at the expense of any one whose tendencies lead him to make a collection of moths, or of shells, of bird-skins, or the like, by those who have not yet become sufficiently acquainted with themselves, and who view these naturalists, (incipient ones perhaps), as mere triflers! Perhaps were these critics to consider a little more they, some of them at least, might recollect that among such triflers they would find the names of Buffon and Linnæus, of Wilson and Bonaparte, of Gould and Gray, of Hooker and Sowerby, with a host of others who rank among our profoundest philosophers. But the realms of natural science are not confined, as is too often supposed, to the mere study of terrestrial organisms, but reach far into boundless space, as well as into all the elements and combinations of which this world of ours is constructed. While the astronomer has acquired data by which he can weigh, as in a balance, each member of the solar system, measure its distance, and calculate the exact time when certain phenomena will be displayed in the heavens for years in the future—the chemist has discovered the combination of simple elements of which all matter is composed—the electrician has at length got a clue to the subtle influences and properties of magnetism,—and the geologist is daily throwing some new light upon the laws under which the great masses of rock, called the crust of the earth, have been accumulated.

The study then of natural science—or otherwise the laws of nature, is simply *infinite*. True we have discovered many of those laws, and applied such knowledge to our use, and we shall in all probability go on discovering still more, but with all our modern knowledge we find that instead of having learned everything, we are only just sufficiently far advanced to know that our researches have but now begun. The laws with which we are now so familiar, and are capable of utilizing, for our comfort, our commerce and daily necessities, although long hidden from the inquiring mind of man, were the same myriads of years previous to man himself being called

into existence, or before any living thing crawled or grew upon the earth. How many ages passed, and how many philosophers lived and died, before the simple occurence of an apple falling from a tree, suggested inquiry into the laws of gravitation and attraction? And how long was it before the expansive power of water was observed, although the every day act of boiling a kettle was an immediate illustration of the fact? Yet in either case there was nothing new; the apple would have fallen towards the centre of the earth, and water would have expanded into steam, thousands and millions of years ago, as it does now—and will do to the end of time. The mighty powers we now possess, in all our appliances of steam or electricity are but the result of a study of nature's laws, by intelligent and inquiring minds.

But now to pass on to our more legitimate subject. If there had been no conchologists, nor entomologists, no ornithologists, nor icthyologists, no botanists, nor zoologists—where would have been our comparative anatomists, or palœontologists—our fossil florists or our microscopists—where our Cuviers, our Owens, our Agassiz or our Carpenters, whose labors and studies, are of such paramount value to geological science. How could we have acquired a knowledge of the conditions under which this planet existed myriads of years ago, had we remained in ignorance of the conditions of the present day? Or how finally could we have ascertained that the great chain of animal and vegetable life, linked as it is together from the earliest to the latest epoch, is nevertheless distinctly marked by a gradual progression and development which cannot he mistaken? I fancy I now hear some one whisper "there he goes at his fossils again!" Very true—he does go to his fossils—and what is more, he again reiterates that these fossils—dull, common, road-side stones though they be—are among his best friends and acquaintances, and a right jolly good welcome he gives them, whenever they are met with. Yes, they are dead stones now, no doubt, but the day was when they lived, as their congeners live at the present day; and I maintain, that independent of the abstract fact that it would be next to impossible to work out geological structure without them, they must of themselves be of the very highest interest to every reflective or intelligent mind.

To come to the second part of our subject namely Geological Structure, and the *practically* great importance of fossil remains:

Professor Jukes, my distinguished predecessor in this province, says in his introduction to his admirable Manual of Geology:

"We might, perhaps, without impropriety, classify all the Physical "sciences under two great heads, namely—Astronomy and Geology. The "one would comprehend all those sciences which teach us the consti- "tution, the motions, the relative places, and mutual action of the "Astra, or heavenly bodies; while the other singled out for study

"the one Astrum on which we live, namely, the earth. Giving "this wide meaning to geology, it would include all the sciences which "treat of the nature, and the distribution of the inorganic matter of the "globe, as well as those which describe to us the living beings that "inhabit it. These sciences are, First: That of Chemistry and Mineralogy, "which may be called one, which teaches us what are the elements of "which terrestrial matter is composed and what are the laws which govern "the combinations of these elements, into all the variety of known sub-"stances, solid, fluid or gaseous, and the forms, properties and qualities of "these substances; Secondly: The science of Meteorological and Physical "Geography (which may be also looked on as one) which describes to us "the form and disposition of land and water and air, and the distribution "of the temperatures and motions that affect them; and Thirdly: That of "Natural History (or Biology—the science of life) including Botany and "Zoology in their widest signification." Again Professor Jukes says—"In "giving this high place to geology, I have no desire unduly to exalt it at "the expense of other sciences. My object is to shew that this large "view of geology, is not only a true but a necessary one, and that if we "do not sometimes look at it from this aspect, we cannot rightly under-"stand nor fully appreciate what geology is."

And yet this subject, so vast that no man living is capable of taking much more than a part in one or other of its numerous subordinate departments, is frequently spoken of, either as a delusion altogether, or what is worse, is regarded as a matter on which any one and every one, without consideration or study, is entitled to express an opinion; hence many of the empirical fallacies that are but too often promulgated by the ignorant or designing, are credited and received by the sanguine or incautious. I remember some years ago, while I was in Canada, there were a good many young men—gentlemen too—who, notwithstanding their undisputed position in society, had scarcely paid sufficient attention in their earlier life, either to their calligraphy, their Lindley Murray, or their Euclid, and who considered it (as no doubt it was) much better fun to play the gentleman—regardless of expense—than it was to turn their hands to some useful employment; but who in course of time discovered, that, as the small account at the banker's was gradually dwindling down to zero, something must be done to keep body and soul together. But the question arose at once—"What are we to do? What are we fit for? Oh! says one "I will be an engineer," "and so will I," says another; "anybody can be an engineer." And accordingly off they go in a body to offer their inestimable services to one or other of the surveying or levelling parties then operating in connection with the public works. Once engaged, and honored by having permission to carry a levelling staff, or

to bear a chain, these embryo engineers immediately sign their names—as well as they can—at the first public house they happen to stop at, with the initial letters S. I.* after each name, to advertise to the public generally the very dignified and responsible position they occupied. Well, there are many who give their crude opinions on geological matters, and what geology is worth, with as much confi'ence as one of those S. I. would have done upon the construction of a railroad; and who are just about as capable of following out geological structure as the S. I. were of building the road.

Now I do not mean, by this illustration, to reflect upon those who are desirous to learn, and who must begin somewhere and at sometime to form judgments of their own, founded upon experience;—moreover I am well aware that many if not most people have duties of such an imperative nature, of other kinds, to perform, as to make it impossible for them to turn their attention to such subjects as we are now considering, except in the most superficial manner: I only wish to protest against the crude and ill-digested opinions so often expressed by the ignorant or designing, without consideration or any solid foundation, being received and credited as good authority. Now, on the very contrary, I maintain what I expressed when I addressed you last year, that every one or any one who chooses, with any intelligence at all, can always contribute, more or less, and sometimes in a high degree, to science generally, and to geology in particular. For instance, many of the idle boys that go about shooting little birds for mere mischief, were they to learn the art of taxidermy, save the skins of their birds nicely and sell them, they might be the direct means of discovering a species previously unknown, or some peculiarity not before observed if the skins fell into the hands of a naturalist! The seal-fisher or deer-hunter, by simply saving a few heads of different kinds, and especially by saving the teeth, might be the immediate means of discovering some unknown principle in zoology; while any body with a moderately good eye, and a desire to use it, is capable of recognizing an organism when displayed in a stone.

As another instance of that undue pretension of which I complain I knew an old farmer in Canada, who was greatly gifted with self-esteem, and who thought because he had been employed by a certain nobleman, while he was in England, to make a set of excavations to prove the correctness or otherwise of some geological statements made by Dr. Buckland, that he had got the entire science of geology by heart, including chemistry and other subordinate branches. Well, this old gentleman on one occasion thought proper to elect himself Censor of the Geological Survey of Canada, and poor Sir William Logan and I both got awfully handled, Sir William was told *in print*, (and I have the print still in my possession), that he

*Civil Engineer.

was no geologist, or he would certainly not put the importance he did upon the value of mineral phosphate of lime as a manure, because, says our learned friend, in the process of calcining and manufacturing the mineral the *phosphorus would be driven off by heat;* and moreover he had tried rotten wood and fish-bones, and found no benefit had been derived on his land therefrom. As for myself, I clearly knew nothing whatever about my business, or I should have learnt that *all rocks dip to the S. E.;* and that I was utterly in error when I stated the direction that the rocks which were known to contain gypsum and salt would run towards Lake Huron! I answered, as a Scotchman is very apt to do, by asking two very simple questions. First—what his chemical views were with regard to the analysis of burnt bones, which he annually applied to his turnip fields?* and, secondly—what were his proofs of the great mistakes I had made regarding dip, and the position of the saline group? To these questions my dignified friend made no reply, but since that time the mineral phosphates have been worked to a considerable extent in Canada, and not only has gypsum turned up where I indicated, but salt is now beginning to attract great attention in the same region, which is found to hold beds of very pure rock salt.

I trust I have not wearied you with these long-winded stories, as introductory to what I have to say particularly upon geological structure.

Were all geological formations piled one on top of the other, as in this column,† in any one place, the total amount of vertical thickness would not be under 100,000 feet, at the very least, from the top of the Laurentian to the base of the Post-Pliocene, and Sir William Logan has shown that the Laurentian system alone is equal to, if not greater than all the rest put together. But they are not thus piled up in any visible instance, but are distributed in greater or less degree, according to the thickness of strata included in one or other of the formations, and the rate of inclination at which they slope from the horizon. Thus it is that vast areas are occupied by Laurentian rocks in one instance, by Cambrian in another, Silurian in some, and Carboniferous in other cases, and so on in the same way. Perhaps the most perfect epitome of geological structure in the world is to be found, among all its merits, in the "neat little, tight little island" of Great Britain, where the whole sequence has been recognised at one part or another from bottom to top. The sequence however is not always regular,

* As it happens, phosphates are the most indestructible of substances. Hence it is that bones are calcined, crushed and sown in the ground, to yield their phosphates to the roots of plants that require that mineral nourishment.

† Referring to a coloured column. Of igneous rocks and their effects, I for the present will say nothing; for although they have doubtless played a very important part in changing or modifying the geological circumstances of their time, their extent in distribution is but very limited, as compared with the vast masses of purely sedimentary origin.

although in England it is nearly so.‡ There the lower formations, (the Cambrian being in that country the lowest,) occur in Wales, while higher sets of rocks occupy the midland countries, and the highest of all come in on the eastern shores. When I addressed you last year I tried to explain what is termed by geologists conformity and unconformity in the manner in which two different sets of rocks, or formations of different ages come in juxtaposition.

The various formations that comprise the crust of the earth are not wrapped round its nucleus like the peelings of an onion, any more than they are piled up like a pack of cards. The truth is, the formations shown in the column represent, each in its own proper place, the relative positions of precedence occupied by the different members; each member representing a period or epoch of time, of longer or shorter duration. I need hardly inform you, I imagine, that stratified rocks are nothing more or less than sediments deposited in water; and that the sediments themselves are but the ruins of more ancient rocks, worn by the same action as we see daily on the sea shore, and in our rivers and brooks. Now, all the formations represented in the column are sedimentary, Laurentian and all, so that it becomes evident that each stratum at its proper time was a sea-bottom, accumulating sand, mud or lime, according to depth and other circumstances in which lived, died and were entombed the distinctive fauna and flora of the period, to be brought to light again after countless ages had passed away, and the creatures of one world after another had ceased to be for ever!

I have said the Laurentian rocks have a sedimentary origin. For a long time those highly crystalline rocks were supposed to be *Plutonic*, and to represent the cooled surface of an incandescent nucleus; and were consequently termed Primary; which term might be supposed to imply a period of time previous to the distribution of sea and land. They were also termed *Azoic*, indicating that the circumstances of the time were such that animal or vegetable life could have no existence. Recent discovery has proved beyond all dispute that the facts are otherwise, and that this old system was accumulated by the same process as its successors; which process has never ceased—even to the present day. But that is not all; the remains of animal life have actually at length been recognised, and the *Eozoon Canadense*, discovered by Sir William Logan, and described by Drs. Dawson and Carpenter, gives its testimony to the existence of living denizens in that great primæval sea. It would be impossible to give an idea of how the land and water were distributed at

‡ It was upon this fact, no doubt, that my empirical friend, the old farmer, founded his belief that all rocks should dip to the S. E., he supposing that what applied to a certain extent in England must necessarily also apply to the whole Universe.

various intervals during this early period; but if we pass on to the next formation, we can have a glimpse at the probabilities, and begin to show how a continual alternation of emergence and submergence gave origin to that want of conformity of which I have spoken. When the great Cambrian sea was in existence, we must conceive its original bottom to have been composed of the rocks of the age which preceded it; but those older rocks having been previously disturbed and metamorphosed, they had also been removed from the horizontal position in which they were deposited, and were tilted, contorted or broken. Hence the level sea of the time would not spread its sediments as you would lay one carpet on the top of another, but the suspended or agitated material would settle itself according to circumstances, on the irregular surface, filling up hollows and valleys on the one hand, while the coarser matter would be arranged on the submarine hills and shallower parts on the other.

The only dry land in these early days must also have been Laurentian, but that may have been of great extent, as indeed there is evidence to shew it had been, especially in the northern parts of Europe and America; and it is pretty clear that a great part of Newfoundland may have shown ranges of hoary heads above the water, while but a small corner of Scotland was all that then existed to represent the British Islands.

It would be tedious, and would occupy too much time to enter into particulars as to all the wonderful changes that formation after formation has undergone, previous to each commencement of a new state of circumstances. Suffice it is to say that each in its turn began, continued, (mayhap for many ages,) and ended, to make way for further progression, as the animal and vegetable organisms within them were born, flourished and died. The sediments of the Cambrian sea, in course of time, became consolidated; disturbances affected the strata, as they had affected those of the Laurentian age before, and finally, when in the fullness of old age the allotted term of existence expired, a Lower Silurian sea supplied the place of its predecessor, to continue the process of degradation and reconstruction, filled with new developments of organic life.

Referring again to the section, you may be disposed to ask me, by what means all the enormous mass represented by the dotted lines, became removed, to make room for the deposition of Lower Silurian sediments?

The answer is—where the bend was made there was necessarily a weakness; *a tendency* to break—and finally a dislocation which made a way for the drainage of a portion of a continent. We may suppose this drainage to have begun as a mere rill, afterwards swelling into a brook, and then into a great river, and finally becoming an arm of the sea. Added to the degrading influence of running water, and the action of the sea, there was also the wearing and denuding influence of the atmosphere.

Let us quote an example in point, which many here present may have seen; and those who have not I hope will see it. I refer to the Falls of Niagara. The magnificent Niagara River must, within what is geologically termed *modern times*, have fallen over a precipice at Queenstown Heights into Lake Ontario—seven miles below the position of the present fall. The time it must have taken to wear out the chasm as we now see it, doubtless was very great; but still there are some rough data upon which to found an approximate idea; and Sir Charles Lyell in his Travels in North America, has computed the necessary time to have been about 35,000 years. Since I first knew the Falls of Niagara, the table-rock has given way twice or three times; that is in the period of about thirty years.

Sir C. Lyell says: "Goat Island has lost several acres in area in the last four years, and I have no doubt that this waste neither is, nor has been, a mere temporary accident, since I found that the same recession was in progress in various other waterfalls, which I visited with Mr. Hall, in the State of New York. Some of these intersect the same rocks as the Niagara, for example at the Genesee at Rochester; others are cutting their way through newer formations; as Allan's Creek, below LeRoy, or the Genesee at its upper falls at Portage. Mr. Bakewell calculated that, in the forty years preceding 1830 the Niagara had been going back at the rate of about a yard annually; but I conceive that one foot per year would be a much more probable conjecture, in which case 35,000 years would have been required, for the retreat of the Falls from the escarpment at Queenstown to their present site, if we could assume that the retrograde movement had been uniform throughout."

Speaking of the age of the strata over which the waters of the Niagara fall, Sir Charles again says: "Many have been the successive revolutions in organic life, and many the vicissitudes in the physical geography of the globe, and often has sea been converted into land, and land into sea, since that rock was formed. The Alps, the Pyrenees, the Himmalaya, have not only begun to exist as lofty mountain chains, but the solid materials of which they are composed have been slowly elaborated beneath the sea, within the stupendous interval of ages here alluded to."

There is very conclusive evidence to prove, that during the Lower Silurian period, there must have been a vast tract of dry land on what now constitutes the northern part of the North American continent; and it is shown in this way. The rocks of that period are found to run up the valley of the St. Lawrence, resting unconformably on the upturned and contorted edges of either the Laurentian or Huronian series, (the latter being assumed to be the equivalent of the Cambrian age;) whereas at Lake Temiscamang and further north towards the shores of Hudson's Bay,

while the Lower Silurian rocks are altogether absent, the Upper Silurian part of the series is recognized, resting on the older formations in the same manner. We may thus fairly assume that the sea of the Lower Silurian age, rolled at the foot of the Laurentide and Huronian mountains, for many ages previous to the submergence which followed, and gave origin to the newer accumulations.

Such processes then, as I have endeavoured, I fear very feebly, to describe, have gone on from epoch to epoch, from the very earliest periods to the present time; and although the changes going on now are so slow as to be almost imperceptible, they are nevertheless as sure, as that each successive day must run its course to contribute its little quota to the vast intervals of time that preceded it.

It would be superfluous to tell you all the difficulties attendant upon the working out of such problems as that of Geological structure; but the difficulties are especially felt where the strata have been greatly affected by disturbing forces; or much changed in condition by igneous or chemical agencies; indeed many instances might be quoted, where it would have been utterly impossible to extricate the complicated entanglements at all, had not a friendly fossil now and then appeared to reveal its own particular horizon, and give a clue to the rest. And here it is again that the naturalist comes to our aid, and shows us the principal forms of organic life we may expect to find as the peculiarly representative types of one or other of the formations or ages. It is fortunate for us also that there are parts of the world, comparatively very little disturbed, even from those very ancient times, where the sequence of the successive formations is nearly as evident as the steps of a stair, and the super-position unmistakable, so that the relation of the typical organic remains of the different formations is, in such a case, clear and intelligible. This condition of things has obtained preëminently in the peninsula of Western Canada, and the State of Michigan, where all the formations from the Lower Silurian to the Coal Measures, succeed each other with nearly perfect regularity, undisturbed and unbroken. Very different however are the circumstances under which these same formations appear, when we recognise them again to the south and to the east, where, along the course of the Appalachian chain of mountains, or parallel to it, the same rocks are found more or less changed in condition, and several of the formations are unconformable with each other. These disturbances, which are well displayed in the lower part of the river and on the Gulf of St. Lawrence, extend to this island, in a high degree; and this brings us to the third part of our subject, namely, the geological structure of Newfoundland, and the importance of a knowledge of that subject, as bearing on the development of its various natural resources.

There is said to have been an old tradition among the aborigines of this island, that when the Great Spirit was in the act of constructing the world, he took the chips and rubbish derived from the manufacture of the other parts, and throwing them into a heap in the sea, accidentally created Newfoundland. Whether this sarcasm originated with the Red Indians or was invented for them is of little importance; but there can be no doubt that the rugged and iron-bound coast which the island presents on all its sides, the dreary and barren aspect of its hills as seen from the sea, and the gloomy nature of its climate, must often have struck the mariner from other countries with awe, the traveller with dread, if not with horror, and the agriculturist with despair. A more close acquaintance with the facts, however, will give very different impressions. That iron-bound, inhospitable coast possesses harbours equal to any in the world; those barren mountains are an elysium to a sportsman; many of the valleys between the ranges are of excellent soil; and the climate almost anywhere, except on the south-eastern and southern sides, equal, if not superior, to that of any of the sister colonies. In short, nature has by no means dealt her favors out grudgingly to this island, and chaos *might* become Cosmos in more ways than in its geological structure, which at first sight appears chaotic enough, in all conscience.

The lower formations are largely represented in Newfoundland, and some of the higher ones to a considerable extent. Beginning as usual at the bottom, the lowest are:

1—Laurentian.
2—Cambrian or Huronian.
3—Lower Silurian to the top of the Quebec Group.
4—Upper Silurian, in small amount.
5—Devonian.
6—Carboniferous.

These formations have all been recognized, and their distribution to some extent followed out by myself, at one part of the province or another. The greatest display of the Laurentian is in the Long Range Mountains, which extend from Cape Ray to the River Castor in nearly a straight line. It also comes to the surface on the axis of a set of parallel anticlinals, or is brought up by great dislocations, several times, and apparently constitutes the most conspicuous ranges of mountains, all of which trend about N. N. E. and S. S. W. from the true meridian. This section will give a rude idea of what I mean.* Here it will be observed the lowest strata make the highest elevations, the Cambrian system flanks the sides of the hills, the Silurian rests on the upturned edges of the Cambrian, and the coal measures are spread indifferently, and of course uncomformably, over all.

* Shown in a diagram.

Of the Cambrian system I have a good deal to say, as I believe I was one of the first in America, who, recognizing the existence of those ancient deposits, pointed out their relation to the Lower Silurian system. The great Huronian series of the west, I have little doubt, is in reality Cambrian, but that opinion is founded entirely upon the position it occupies between the Laurentian and Lower Silurian systems. In those western regions, notwithstanding the most diligent search at many different parts of the distribution of the series, (and I worked in that region for nearly seventeen years), I never could find a fossil. Here, as will presently be shown, I have had better luck. Five years ago, I observed, when visiting Topsail for the first time, that there was a decided difference, in many respects, between the rocks which form the lofty cliffs of the main land, and those of the islands in Conception Bay. Further researches proved the formations to be unconformable to each other, and consequently that a vast difference in age must exist between them; and still farther investigation produced fossils of the type of the very lowest members of the Lower Silurian, from the *upper or more recent* formation. With this evidence, backed moreover by a certain lithological resemblance, I, in my own mind, came to the conclusion that the rocks of the main land were of Huronian age. But still I hardly dared to state that such was the fact, without further evidence; nor would I assert that the Cambrian and Huronian were positively the same thing. Latterly, however, so far as this country is concerned, the great prize of all has been obtained, and the mystery revealed. Thanks to my friend, the Rev. Mr. Harvey, whose enlightened mind is ever ready to find a text, if not a sermon, in a stone, a fossil of so truly a Cambrian type was discovered that, although the forms have not yet been referred to a naturalist for examination, I have no doubt left about the age of the rocks from which they proceed. I had a few specimens resembling the one I now refer to, besides one or two others from the same rocks, long ago, but none were well defined; in fact they were so obscure as to create a doubt whether the forms had any organic origin at all. Although it will still be necessary to have the verdict of a palaeontologist upon our organic forms, I now feel so confident of the age of the rocks of this peninsula, that I think we may without danger assume that their place in our column is Cambrian.

The Lower Silurian rocks which succeed the Cambrian are also largely distributed in many parts of Newfoundland, although no member of them higher than the upper part of the Quebec group has yet been recognised. On the peninsula of Avalon no part has been found higher than the Upper Potsdam, and that only on the islands in Conception Bay. It so happens, however, that the Quebec group is displayed in great force in many parts of the province, and as that group, especially the middle part of it, is the acknow-

ledged great metalliferous zone of eastern North America, it must be regarded as a possession and inheritance beyond price. It is true that fossils are rarely found in this metalliferous part, to exactly mark its horizon, probably in consequence of the metamorphism the rocks have undergone—but the underlying strata being usually highly fossiliferous, its true position in the geological sequence is still sufficiently manifest; while its lithological characters, are so peculiar and so constant that mistakes in superposition need not occur, if proper attention be paid to the structure and geographical distribution.

Of the Upper Silurian group, as far as my investigations go, up to the present time, there appears to be but little; and that is situated near Sop Island, in White Bay; nor of the Devonian series, have I yet discovered any great spread over the surface, although a considerable thickness is displayed on the peninsulas of Cape Rouge and Fox Cape, at the north-east end of the island. The Carboniferous formation occupies an extensive area on the central and south-western parts of the island; and this appears to be the highest of the old formations in Newfoundland.

Having now given a rough sketch of the manner in which the formations are distributed, let us consider what practical results may be expected from all the time and labor bestowed upon this enquiry. To the man of science, the subject is sufficiently interesting and instructive of itself to reward all the toil and trouble he has been put to, in the acquisition of so many new facts; but to those who have never been attracted towards scientific matters, or are absorbed in business, so as to have neither time nor inclination to satisfy themselves of the value, or otherwise, of such labors, some explanation of the benefits to be derived from geological investigation is necessary. There certainly has been an impression, here as elsewhere, that the business of a geologist is to go about indiscriminately, hither and thither, to point out the position of mines, and failing to do so, or I may rather say, failing to work impossibilities, he is supposed to be incapable to perform his legitimate functions. Now I beg to assure you that such notions are simply proposterous and absurd; and although there are charlatans who will profess to have the power of working miracles, such as discovering gold, or silver, or buried treasure, or springs of water, by means of a crooked stick, the geologist *dare* not risk even a moderate reputation by playing the mountebank. No, he goes patiently and ploddingly along, collecting his facts together, before he constructs his *map* to lay before the world; in the same way a ship's carpenter may be supposed to get his materials piled in order, before he begins to build his ship. According to the charlatan, the ship would be built first, and the timber of which she was constructed cut down afterwards!

But even admitting that the geologist was such a miracle-monger,—let

us suppose that his duty was simply to locate mines. Is it not obvious that the time he would require to bestow upon one location would embrace, at the very least, one whole season? And would his employers not find, that to *prove the ground alone*, would cost them more thousands of pounds than a systematic survey does hundreds? I put those questions to any capitalist who has had experience in mining operations, either in this or any other country.

I said *to construct his map*, and I say so again advisedly; for it is on the information expressed by colors on that map, that the character of a country is revealed, and its capabilities recognized, as well for the future as the past. Dr. Buckland, many years ago, in his celebrated Bridgewater Treatise, says: "Shew me a geologically-colored map, and I see also a map of the distribution of the manufactures of a country." Surely if that remark applies in giving a stranger a succinct view of things as they are in old countries, like England or France, how much more will it truly apply to a new and unknown country, as showing where the manufactures are destined to be in days to come; and point to circumstances which may influence or modify the character of a whole people.

Now in constructing a geological map, it must not be supposed that by dotting a fact here and another there upon a blank sheet of paper, by guess, or drawing a set of straight or crooked lines upon its surface, one is likely to derive much instruction for himself, or give information for his neighbours; he would rather be deluding both. In a country like this one, for example, he must in one way or another, survey topographically every bit of ground he examines; otherwise his conclusions will either be altogether fallacious, or at least his facts, in regard to position, distorted. Imaginary geographical maps of the interior of Newfoundland I have seen, and have in my possession, upon an impractically small scale, but in no one solitary instance, have I found any of the great features, back from the coast, in their proper position; nor anything nearer than the rudest resemblance to them in form. Hence it is that I have found it necessary to be my own geographical surveyor—and I hope I may be pardoned for a little egotism, when I say that I believe these surveys will be found to be nearer accuracy than any that have ever been made inside the coast of the Island. Now while making these surveys, although the main object of course was to record the geological facts accurately, the superficial character of the country was never neglected; care was taken to note all particulars regarding soil, timber, water-power, contour in a rough way, of elevations and depressions; on one occasion a collection of wild plants was made to illustrate the native botany; and in short, attention was paid on all occasions to every peculiarity which might lead to general information or instruction. It was upon data obtained upon those surveys that I was

enabled to show, as I did when last in England, in an article I published in the Journal of the Society of Arts, that in the valley of the Humber, together with the region around St. George's Bay, there are about 446,000 square acres of land, more or less fit for settlement. My words in that article are, after giving those figures: "These valleys are for the most part well wooded, producing in many instances large pines, juniper or tamarack, fine yellow birch, and other valuable timber. In the valley of the Humber this is especially the case, where a large area of country appears to be provided with all the necessary material for ship-building in a remarkable degree."

While I was in Canada, it fell to my lot to have to do a great deal of topographical surveying, in connection with the geological investigation; and the value of those surveys, simply in a geographical point of view, has been acknowledged by the Crown Lands Department of that Province, to have been a saving to the Government of many thousands of pounds, in shewing the positions best adapted for laying off townships for settlements, as well as the parts most favourable for carrying on great public works. We may now wind up this part of our subject by saying, that a country without a map must still be in its swaddling clothes, and I emphatically say it is a fact, that for want of one, the interior part of this Island of ours is at this moment more a *terra incognita* than the centre of Africa.

So far for the surface. Now, as to the geological colors on our map: We will suppose that each color, as given here in the column, is laid on over the surface of the map, so as to show the boundaries of the different formations. Here any one can see at once that the red represents the Laurentian, the brown the Cambrian, the blue the Silurian, the black the coal, and so on. Now as each system has some mineral characteristic peculiar to itself, the speculator or adventurer can readily determine in which section of country he is most likely to discover the substances he requires, as well as to conclude where such substances need not be expected. In this way a capitalist, desirous of some new enterprise for investment, in England or elsewhere, sees, by looking at our map, what the probabilities are of this substance or that existing in the province at all, in the first place; and then where the parts are in particular where experiments may be tried with the best chances of success, in the second. For instance, were he an iron-master, he would turn a good deal of attention to the Laurentian section of the country; were he a gold-hunter, he would have an eye to the Cambrian; should copper in particular be the attraction, he would look keenly towards the Lauzon division of the Quebec group; and were coal the great object of all, as it well deserves to be, he knows in a moment where alone there is any probability of its existence.

I have said that the gold miner would have an eye to the Cambrian

rocks, and in saying so perhaps I am a little before my subject, and for this reason. Our neighbours in Nova Scotia are perhaps ahead of us here in Newfoundland, in one respect; they have found a gold-bearing quartz, but they have not yet identified the age of it: they have not yet found a mark like the precious stone, which I now hold in my hand, to authorize a distinctive color to be put on their map, by which it may be known all over the world. Here, on the other hand, we have, by this same unpretending stone, a record of the past, by which we are enabled to establish the true position of the rocks to which it belongs in the geological arrangement, and I am collecting with much care specimens of the quartz veins which intersect it to be sent to Canada for analysis.

In a letter I lately received from Dr. Sterry Hunt, than whom there is no better authority in America, he says: "the Nova Scotia gold rocks might be, from their position, anything. They are a series of metamorphic rocks resting apparently on old gneiss, overlaid directly by Devonian and Carboniferous very little altered, and might be Huronian or Lower Silurian. It would seem strange, however, that the whole Lower Silurian should be represented in Nova Scotia by nothing but quartzites and slates, and I am quite ready to believe that the rocks are Huronian or Cambrian." Mr. Billings also says, upon the fossils submitted to him for examination, "you have the whole series, Cambrian, Primordial, Lower and Upper Potsdam." Dr. Hunt again remarks, "it will be a great pity if you have not means to work out further the structure of this curious island."

Now you may perhaps say "What odds about the structure if the gold is found?" The odds are these—that were the age of the Nova Scotian rocks ascertained, as I have little doubt it will be by and bye, by the same means that we have identified our rocks here, and the two are proved to be contemporaneous, the geological map I hope to produce will be the direct herald to proclaim to the world that the auriferous rocks extend to Newfoundland, and will certainly stimulate the cupidity of numbers, from all parts, to try their luck in pursuit of the precious metal.

With respect to copper, I will simply give an illustration, to show how greatly a geological map would facilitate the discovery of places favourable for mining. Suppose our friends, Mr. C. F. Bennett or Mr. Smith McKay, had been in possession of a map on which the Lauzon division of the Quebec group was represented, its metalliferous peculiarities being known, how many years of labor, and how many thousands of pounds in outlay would it have saved them, wandering about the country—looking here and looking there—always thinking they had hit upon the right place, but never finding it, till the Tilt Cove location was hit upon at last by mere accident? Many of the greatest discoveries have been the result of

accident, as my friend, Professor Bell, told you the other evening; but in the case I now refer to, where an accident certainly was the means of fixing upon the location, I have Mr. McKay's own authority for stating that it was upon a hint from Dr. Dawson, of McGill College, Montreal, that he was induced to examine the north-east part of the country at all; the Doctor's opinion being founded upon the probable position of the serpentines, which the Geological Survey of Canada had shown to be so fruitful in copper, and the relations of which in Newfoundland that survey had pointed out

But of all mineral substances, there does not exist one in regard to which a good geological map is so essentially necessary to shew the distribution as coal. And here it cuts two ways. First in shewing where the coal rocks lie, and, in more detail, where the workable seams may be expected; and, secondly, where they are not, and never will be found at all. The negative information is only second in importance to the positive; and we have no less authority than that of Sir Roderick Murchison for saying that the capital wasted in futile researches for coal would be sufficient to pay for a geological survey of the whole globe."

Apropos to coal researches. Last year I related a few anecdotes about some such futile experiments having been attempted in Canada, under the guidance and direction of what are usually termed *practical miners*, in each instance; but I forgot at the time to mention another, certainly in a very small way, which came under my cognizance in Newfoundland.

While I was working up the structure in the Bay of Islands, I was informed by several of the residents there, that coal had been discovered at no great distance from the mouth of the Humber River, and several specimens of coal were shown to me, said to have been extracted from the bed. I insisted on the improbability of coal being found in Silurian rocks, but in vain; some of my informants who knew the spot well, undertook to convince me by taking me there, that I might judge for myself. Imagine my surprise, when I found that the place indicated was not in solid rock at all, or even in gravel or sand, or clay; but among the vegetable mould of the surface! Clearing away this ground with a pick and a tomahawk, I soon came to the said *coal*, sure enough, piled upon a floor of sawn deals, supported on hewn logs, the amount of fuel remaining being probably three or four bushels! On further enquiry I discovered that a vessel had been built there about forty years previously, and the wonderful coal mine was the remains of what had been used for the blacksmith's forge! And yet, absurd as it may appear, this coal mine, as it was called, was so currently believed in, that some parties (so I was told) were proposing to load a vessel with the fuel to take to St. John's as a speculation, or perhaps a puff!

In my own researches in St. George's Bay, I took particular notice of the structure of the coal field there, in order to show where the workable seams were likely to occur, and where they were not; and upon the strength of probabilities, I laid down the position of an outcrop upon my map, which position, in consequence of having broken my leg, I could not reach. This ideal seam afterwards proved to be a substantial fact, as my friend, Professor Bell, has told you, he having since visited the spot; and he has given his testimony to the accuracy with which the seam was laid down upon the principle of structure alone. In consequence of a great fault cutting off a considerable segment of the coal trough, the extent of the coal seam or seams, will be limited; but by a calculation which I made the other day, if we suppose the plane of one seam, three feet thick, to occupy an area of 38.4 square miles—which it would, as drawn on my map—that seam would contain 54,720,000 chaldrons of coal.

Besides all the minerals of which I have spoken, there are scores of commoner substances, such as limestone, building stones, whetstones, etc., of vast importance to any country, which abound in this island; the position of all which would be indicated on our map or described in the text. Of these substances, roofing slate is one which cannot fail to become, one day, of great importance. From what I have seen, this will be chiefly found in the rocks of Cambrian age; in which case the conditions of our rocks here will have still another characteristic in common with their equivalents on the other side of the water; as it is in the same system, that the celebrated slates of Caernarvonshire are situated.

But I fear I have already trespassed too much upon your time, and will consequently cut the matter short, by expressing a hope on my part, that we may all meet again, to discuss the truth of what I have here stated, after some years more of experience. I need hardly inform you that I am no chicken now; but if I am spared but a few years more, I feel confident, first of all, that we shall have a MAP OF NEWFOUNDLAND, that I shall see its lands opened systematically for settlement, its forests utilized and become a great source of revenue, its minerals opened up and the country intersected with roads, by means of which I hope I shall be able to get a fresh cod-fish for breakfast or dinner, which is more than I can do at present.